Determinants of Biomedical Waste Segregation intention and Behaviour among Healthcare Professionals in Kumaun Region of Uttarakhand: An Integrated TPB-NAM Study

A

SYNOPSIS

(THESIS PROPOSAL)

SUBMITTED TO

THE ICFAI University Dehradun

IN PARTIAL FULFILLMENT OF THE REQUIREMENT

FOR THE AWARD OF THE DEGREE OF

DOCTOR OF PHILOSOPHY (Ph.D.)

IN

MANAGEMENT

BY

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Candidate's Declaration

I, **Amit Dumka**, declare that the synopsis entitled, ***Determinants of Biomedical Waste Segregation intention and Behaviour among Healthcare Professionals in Kumaun Region of Uttarakhand: An Integrated TPB-NAM Study*** being submitted in the partial fulfillment of the requirement for the award of the degree of Doctor of Philosophy in **Management** under ICFAI Business School, The ICFAI University, Dehradun during the academic year 2025-26. It is the work that is expected to be carried out under the supervision of **Dr. Rakhi Shukla**. It is further declared that the synopsis is within the plagiarism limit and copy of the same is attached as per the University norms.

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Acceptable Maximum Limit	10
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Paper Title	Determinants of Biomedical Waste Segregation Intention and Behaviour among Healthcare Professionals in Kumaun Region of Uttarakhand: An Integrated TPB-NAM Study
Similarity	4%
Paper ID	5592888
Total Pages	48
Submission Date	2026-05-04 09:28:43

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TABLE OF CONTENTS

List of Tables		***6***
List of Figures		***7***
Abstract		***8***
1	Introduction	9
2	Literature Review	14
3.	Research Gap	25
4.	Research Objectives	27
5.	Conceptual Framework & Hypothesis Development	28
6.	Research Methodology	31
7.	Scope of the Study	36
8.	Practical Implications and Limitations of the Study	36
Annexure-1:	***Month wise Plan of the Work***	38
	Bibliography	39

LIST OF TABLES

Table No.	Description	Page No.
1.1	Colour-Coded Segregation of Biomedical Waste	10
2.1	Summary of Models in the areas of BMW	20
2.2	Most utilized theories / models	22
2.3	Bibliometric analysis of the extracted literature from the Scopus and WoS databases	23
3.1	Identified Research Gaps and Opportunities in Biomedical Waste Management	26
6.1	Proposed Mixed-Methods Design: Data Sources, Collection Methods, and Integration Points	35

LIST OF FIGURES

Figure No.	*Description*	*Page No.*
1.1	Schematic representation of biomedical waste management as per Biomedical Waste Management Rules, 2016	10
1.2	Categorization & Classification of Wastes in Health Care Facilities.	12
2.1	Knowledge–Attitude–Practice (KAP) model adopted from Cleland (1973)	15
2.2	The Health Belief Model (Adapted from Rosenstock, 1974).	16
2.3	Theory of Reasoned Action (TRA), adapted from Fishbein and Ajzen	17
2.4	Theory of Planned Behaviour (TPB), adapted from Wang, Guo, Wang, Zhang and Wang	17
2.5	Norm Activation Model (NAM), adapted from Wang, Guo, Wang, Zhang and Wang	18
2.6	Social Cognitive Theory was developed by Bandura (1986)	18
2.7	Organizational and Institutional Theory developed by Meyer and Rowan (1977) and DiMaggio and Powell (1983).	19
2.8	The Integrated TPB–NAM framework was developed by combining the Theory of Planned Behaviour (Ajzen, 1991) and the Norm Activation Model (Schwartz, 1977)	20
2.9	Boolean Search Results from Scopus Database	22
2.10	Flow diagram for the selection of study	25
5.1	Theoretical framework of Proposed Model	30

ABSTRACT

Biomedical waste segregation (BMWS) remains a persistent public health and environmental challenge in India despite the existence of comprehensive regulatory provisions under the Biomedical Waste Management Rules. In many healthcare facilities, routine segregation practices do not consistently align with prescribed guidelines, resulting in occupational, community, and environmental risks. These challenges are particularly evident in ecologically sensitive and resource-constrained regions such as the Kumaun division of Uttarakhand. This study examines factors associated with biomedical waste segregation practices among healthcare professionals working in public and private healthcare institutions.

A mixed-methods approach is used. Quantitative data are collected through a structured questionnaire administered to healthcare professionals across selected healthcare institutions in the Kumaun region. The survey is informed by constructs drawn from the Theory of Planned Behaviour and the Norm Activation Model and is analysed using structural equation modelling to assess biomedical waste segregation intention and self-reported behaviour. Qualitative data are generated through in-depth interviews with healthcare professionals to document biomedical waste segregation practices, institutional routines, availability of infrastructure, training exposure, monitoring mechanisms, and operational constraints within healthcare facilities.

The study provides empirical evidence on biomedical waste segregation practices in healthcare settings and extends the application of established behavioural theories to the context of biomedical waste management. The findings offer practical insights for policymakers, hospital administrators, and regulatory authorities to strengthen training programmes, administrative measures, and infrastructural support for biomedical waste segregation, particularly in environmentally vulnerable regions such as Uttarakhand.

Keywords

Biomedical Waste Management; Biomedical Waste Segregation; Healthcare Professionals; Theory of Planned Behaviour (TPB); Norm Activation Model (NAM); Personal Norms; Behavioural Intention; Mixed Methods; Kumaun Region; Uttarakhand.

1. Introduction

1.1. Global and National Context of Biomedical Waste Management

Nearby many hazardous materials in the field of medical which are recommended by global and national agencies in the category of biomedical management waste these includes equipment's like syringes, scalpels, needles, toxic chemicals, blood etc. The disposal of these medicinal bio-waste equipment's possesses a serious health and environmental problems, which make bio-medical waste managing (BMWM) as an important field to explore in order to protect health of human along with preventing the harmful effect of environment. India being a developing nation faces significant challenge in the field of biomedical waste management. In India, the rate of increase in population is very high and also there been seen as increase in medical facilities in India which poses a serious threat in this field.

In an study, it is find that the estimated biomedical waste generated by India is 614 ton daily which is generated nearly from 2,70,416 hospitals across India and managing such a high waste is a matter of concern.

1.1.1. Definition of Biomedical Waste

International Definition (WHO): The World Health Organization (WHO) defines medical waste, also known as healthcare waste, as waste engendered by healthcare activities. This broad category includes a Various materials, ranging from discarded spines and nozzles to contaminated dressings, human tissue, diagnostic tasters, blood, elements, pharmaceuticals, medical devices, and emitting radiation materials.[37] It encompasses waste produced within healthcare facilities, examination centers, as laboratories related to medical procedures and equipment, as waste from minor and scattered healthcare sources, such as home-based care (e.g., home dialysis, self-administration of insulin).[38]

Globally, it is projected that approximately 15% of healthcare waste is hazardous and carries the potential to cause disease or injury. The remaining 85% is considered general, non-hazardous waste, similar to domestic household waste, including items like paper, glass, plastic packaging, and food that have not come into contact with patients. [38] However, in low-income countries, the actual quantity of hazardous waste can be higher due to improper segregation, which chiefs to the contamination of the entire waste stream. [5]

National Definition (India): In India, biomedical waste is broadly defined as any solid, fluid, or gooey waste, together with its container and any in-between product, through the verdict, treatment, or immunization of humans or animals, in related research, or in the production or testing of biological products and animal waste.[8] This includes materials such as bandages, cotton, soiled linen, body parts, needles, syringes, medicines, and laboratory wastes, all of which carry infection.[7]

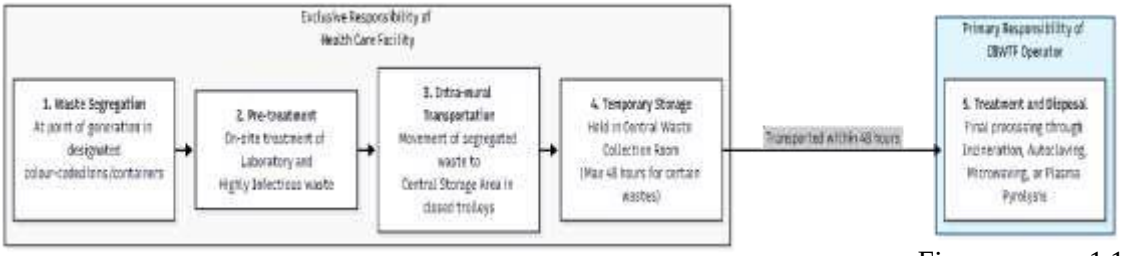

Figure 1.1: Schematic representation of biomedical waste management as per Biomedical Waste Management Rules, 2016 [5]

Biomedical Waste (Management and Handling) Rules, 1998, published by the Government of India, specifically address the managing and treatment of biomedical waste. [8] These rules, along with subsequent revisions like the Biomedical Waste Management Rules, 2016, regulate the disposal of various categories of BMW to ensure the safety of healthcare workers, patients, the public, and the environment. [39] Biomedical waste from healthcare activities is recognized as posing a higher hazard of Infection and damage compared to other types of trash. [39]

Table 1.1: Colour-Coded Segregation of Biomedical Waste [5]

Colour Code / Category	Type of Waste	Colour & Type of Container (As Prescribed)
Yellow Category	• Human bodily waste • Animal functional waste • Soiled surplus (items contaminated with blood/body fluids such as dressings, cotton, linen)	**Yellow, non-chlorinated plastic bags or containers**

	• Expired or superfluous medicines, including cytotoxic drugs • Clinical laboratory waste (microbiology, biotechnology, and other) • Chemical unused (solid)	
Red Category	• Contaminated recyclable waste including tubing, bottles, intravenous sets, catheters, urine bags, syringes (without needles), gloves	**Red coloured, non-chlorinated plastic bags or containers**
White Category (Translucent)	• Waste sharps including metals such as needles, syringes with fixed needles, scalpels, blades	**White coloured translucent, puncture-proof, leak-proof, tamper-proof containers**
Blue Category	• Broken or discarded and contaminated glassware • Medicine vials and ampoules (except cytotoxic) • Metallic body implants	**Puncture-proof, leak-proof boxes or containers with blue coloured marking**

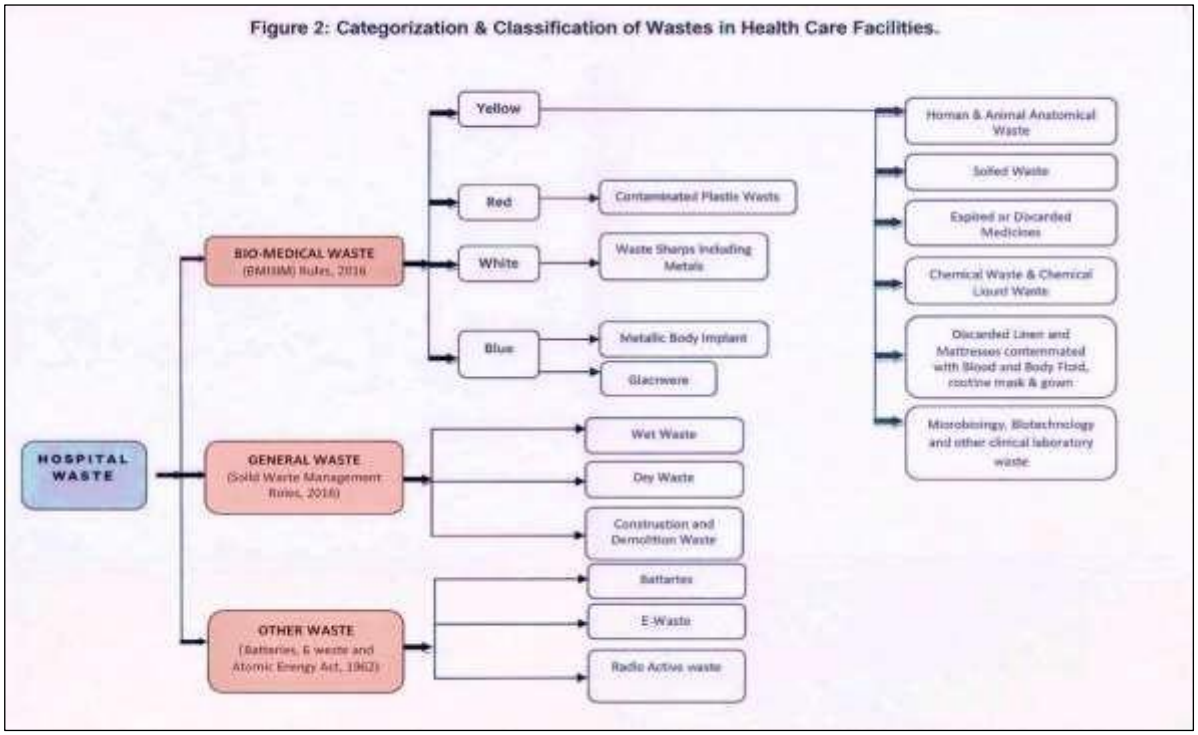

Figure 1.2: Categorization & Classification of Wastes in Health Care Facilities. [188]

1.2. Problem Statement: Challenges in BMWM in India, particularly Uttarakhand/Kumaun

Despite the establishment of strict regulatory frameworks such as Despite the Ministry of Environment, Forest and Climate Change having promulgated the *Bio-Medical Waste Management Rules, 2016*, and the Central Pollution Control Board (CPCB) having provided detailed technical guidelines, India continues to face formidable challenges in effectively managing bio-medical waste (BMW). The gap between legislation and implementation is evident in the disturbing statistic that approximately 53.25% of healthcare amenities in the country operate without necessary authorization from State Pollution Control Boards (SPCBs) or Pollution Control Committees (PCCs). Non-compliance within the biomedical waste management process is not merely a manifestation of administrative oversight; it also exposes the failure of structural elements specifically, the breakdown of regulatory enforcement and inspection mechanisms. We have observed that a substantial volume of biomedical waste remains unaccounted for or is improperly disposed of; this constitutes a large-scale systemic challenge within India's biomedical waste management framework. Moreover, the analysis of these problems in terms of the Theory of Planned Behavior which is a framework created to measure the extent of interaction between behavior, intention and practice reveals the presence of

behavioral, structural and systemic gaps that are at the core of the failure of current management model. Studies have shown that to have an effective biomedical waste management, the segregation of the waste i.e. the use of color-coded bins is a critical point in the whole process. Sorting waste at the early stage of production helps in further processing the waste and effective disposal of the same. By conducting the research in the Kumaun region of Uttarakhand, the study observe a far-flung and need of resource based region where the above mentioned rules on source segregation are not enforced, in general. One of the major reason for this important gap are the three dimensions of KAP i.e. Knowledge, Attitudes, and Practices. The knowledge towards the guidelines of biomedical waste segregation are not completely unknown to different stakeholders such as physicians and senior medical staff. However, they are, in general, lacking among auxiliary personnel such as nurses, sanitation workers, laboratory technicians, contract workers and others, who are directly involved in handling the segregation of biomedical waste. Further, this knowledge gap can be explained and /or improved by conducting the training program to such stakeholders who are directly involved in the process of segregation. Without conducting the training program, these stakeholders cannot trained/mastered in the important operational standards as source segregation and, hence, as a result, they will continue to make mistakes in waste disposal, thereby, increasing the risk of cross-contamination and has a significant negative impact on any potential risks associated with human health and the ecological environment as well. On the another hand, waste management is not given much priority as it remains the secondary activity instead of an significant & essential aspect of the overall public health service delivery system. One of the reason for giving second priority to this important system in the country may be the insufficient funding due to which generally the health care institutions are barely able to afford the basic material resources required to manage the biomedical waste and therefore lack of paying emphasis on biomedical waste management has created an unfavorable environment inside hospitals & their staff as well as in the areas that surround them; therefore, even in situations where employees have their strong intention to dispose the waste material, they are still unable to do that. It is noteworthy that, as per the report on the Waste Management published in 2024 published by the Comptroller and Auditor General (CAG) of Uttarakhand, the rate of segregation of waste at the state waste treatment plants was only 2.23%; and at the point of waste generation, the rate was only 3.1%, and both are considered to be very low, keeping in view of the health of the public. These statistics are very brief reflections of how the region is still unable to effectively

apply the fundamental biomedical waste management (BMWM) methods. In the case of Uttarakhand, a report, released in 2020, stated that the state produces 7, 383.94 kilograms of biomedical waste per day. In contrast to Kumaun region, where there are only 2 General Biomedical Waste Treatment and Disposal Facilities are available for the waste management, they do not allow proper treatment and disposal in the region and hence this issue of concern and research is this direction is taken up to know the determinants of intention to use biomedical waste management. The proposed study tries to address these issues by accessing the various determinants towards biomedical waste management practices.

1.3 Importance of Healthcare Professionals' Role

Healthcare professionals play a vital role in the implementation of an effective and efficient biomedical waste management process, particularly those directly engaged in activities such as segregation, storage, transportation, processing, and disposal. Make them knowledgeable will help in preventing contamination of environment from biomedical waste. As per the studies in context of India, it is found that there are varying levels of knowledge and practice among different cadres of health care professionals like knowledge about coding and waste segregation at the source has found to be better among nurses and laboratory staff compared to doctors, while sanitary staff often demonstrate significant ignorance across various facets of biomedical waste management practices. Thus, this study will help in revealing that need for targeted educational and training interventions tailored to the specific roles and responsibilities of each professional group within healthcare facilities.

2. Literature Review

The literature review was carried out in two phases. In the first phase, an extensive review of theoretical models related to knowledge, attitude, and behaviour was undertaken to develop all-inclusive understanding of the conceptual foundations relevant to biomedical waste management. In the second phase, a focused review of empirical studies specifically addressing biomedical waste management practices among healthcare professionals was conducted, and key findings from these studies were systematically summarized.

2.1 Phase-1 of Literature Review

In this phase, an extensive review of behavioural and health-related theoretical models was

undertaken to develop a comprehensive understanding of the conceptual foundations underlying biomedical waste management practices. Over the past four decades, significant advancements have been made in theories and models aimed at explaining how individuals acquire knowledge, form attitudes, and translate them into responsible practices in healthcare settings. The following section presents a brief overview of the evolution of these models as documented in the existing literature.

2.1.1 Knowledge, Attitude, Practice (KAP) Model

The Knowledge–Attitude–Practice (KAP) model was developed and popularized by Cleland (1973) and later widely used by WHO (1988) in public health and behavioral studies. The model explains that knowledge forms the foundation for developing attitudes, which subsequently influence practices or behaviour. Knowledge refers to awareness and understanding of facts and procedures, attitude reflects beliefs and feelings toward a subject, and practice denotes the actual execution of behaviour. The Knowledge–Attitude–Practice (KAP) model has been used in the study by Mathur et al. (2011) to assess healthcare workers' knowledge, attitudes, and practices related to biomedical waste management in a tertiary care hospital setting.

Figure 2.1: Knowledge–Attitude–Practice (KAP) model adopted from Cleland (1973)

2.1.2 Health Belief Model (HBM)

The Health Belief Model (HBM) was originally proposed by Rosenstock (1974) and subsequently refined by Becker (1978). This model aims to elucidate how individuals' perceptions of health-related risks and benefits influence their health behaviors. The model comprises the following key constructs: perceived susceptibility, perceived severity, perceived benefits, perceived barriers, cues to action, and self-efficacy. Abd El-Salam (2010) applied the Health Belief Model (HBM) to the field of biomedical waste management, demonstrating how perceived risks, perceived benefits, and perceived barriers influence healthcare professionals' adherence to safe waste disposal protocols.

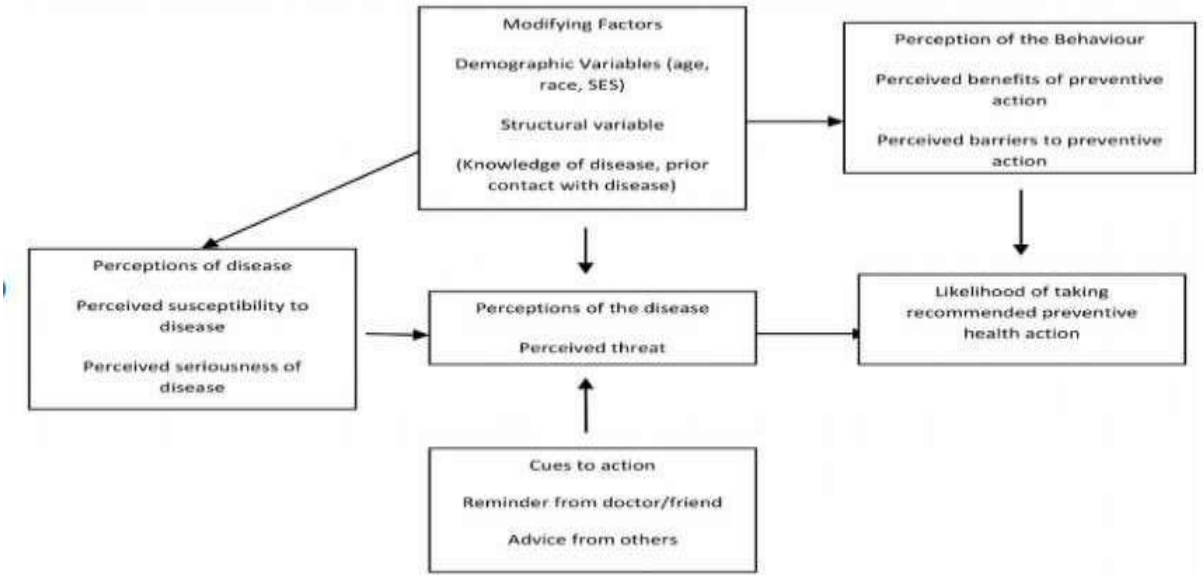

Figure 2.2 The Health Belief Model (Adapted from Rosenstock, 1974)

2.1.3 Theory of Reasoned Action (TRA)

In 1975, Fishbein and Ajzen came up with the Theory of Reasoned Action (TRA) by theorizing the attitude and subjective norm as an predictor of behaviour intention. Further the attitude and subjective norm, both the constructs were theorize to be explained by 02 constructs each such as shown in Figure 2.3. This theory has been widely applied in social science research and the same has been applied by Yadav and Devi (2017) to examine healthcare workers' attitudes and subjective norms influencing biomedical waste management practices.

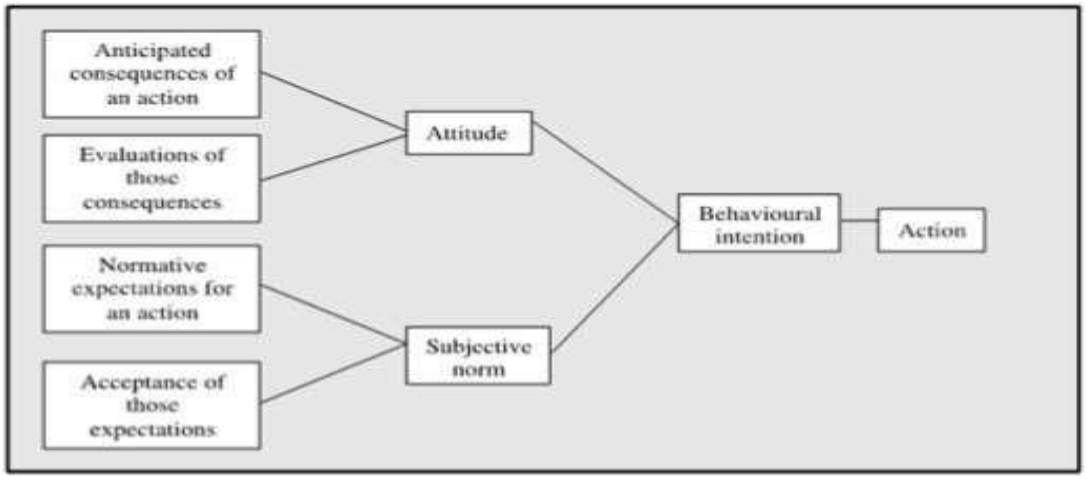

Figure 2.3 Theory of Reasoned Action (TRA), adapted from Fishbein and Ajzen

2.1.4 Theory of Planned Behaviour (TPB)

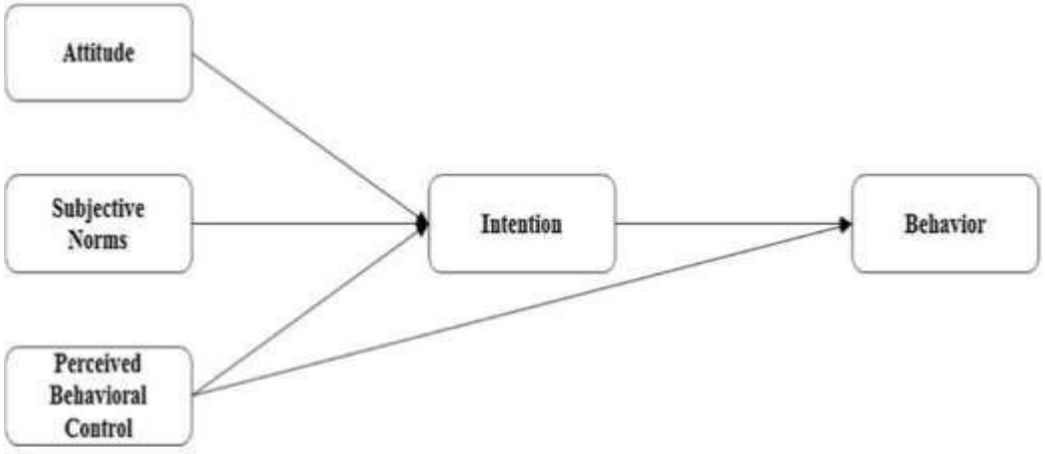

Figure 2.4 Theory of Planned Behaviour (TPB), adapted from Wang, Guo, Wang, Zhang and Wang

The Theory of Planned Behavior (TPB), proposed by Ajzen (1991), serves as an extension of the Theory of Reasoned Action (TRA). TPB introduces the concept of "perceived behavioral control" (PBC) as an additional determinant of both behavioral intentions and actual behavior. Giving to this theory, attitudes, subjective norms, and perceived behavioral control collectively influence behavioral intentions, which, in turn, predict specific behaviors. In their study, Sapkota et al. (2014) applied the Theory of Planned Behavior (TPB) to investigate how attitudes, subjective norms, and perceived behavioral control influence the behavioral practices of healthcare workers regarding biomedical waste management.

2.1.5 Norm Activation Model (NAM)

In 1977, Schwartz introduced the Norm Activation Model to explain why people perform pro-social and pro-environmental behaviors. According to the model, people's actions are guided by personal norms, which are activated through awareness of consequences and conventionally recognized responsibilities. When individuals realize the bad effects brought by their actions and feel they should be held responsible, the formation of personal moral norms is activated. Bolaane (2006) uses the Norm Activation Model (NAM) to explore the moral norms and responsibility of an individual affecting their attitude in managing waste.

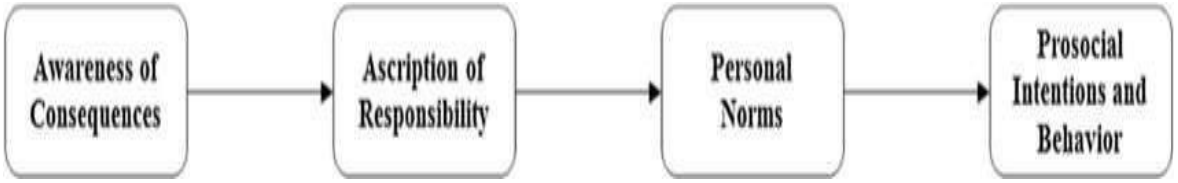

Figure 2.5 Norm Activation Model (NAM), adapted from Wang, Guo, Wang, Zhang and Wang

2.1.6 Social Cognitive Theory (SCT)

Bandura (1986) developed the Social Cognitive Theory, which stresses that behaviour can be regulated by personal determinants and environmental factors. SCT key constructs includes self-efficacy, observational learning, outcome expectations, and reinforcement. The work by Askarian et al. (2004) used Social Cognitive Theory (SCT) to examine the effects of self-efficacy, e-learning, and the environment on Biomedical Waste Management in hospitals.

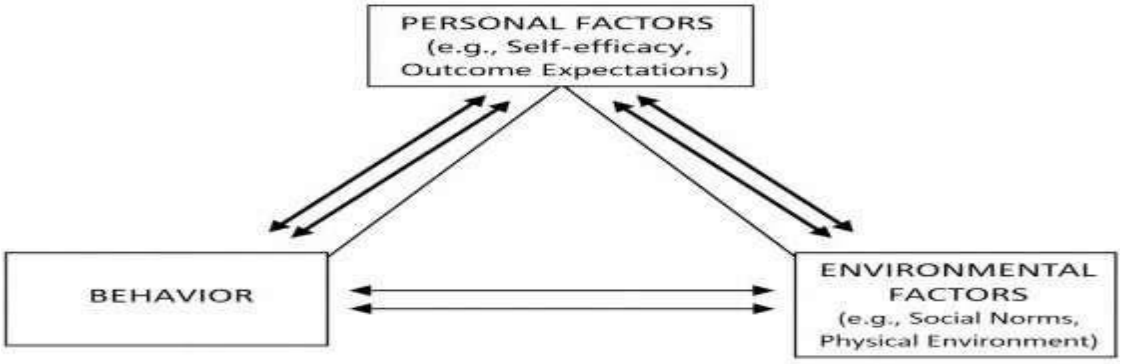

Figure 2.6 Social Cognitive Theory was developed by Bandura (1986)

2.1.7 Organizational and Institutional Theory (OIT)

Organizational and Institutional Theory was advanced by scholars such as Meyer and Rowan (1977) and DiMaggio and Powell (1983). The theory explains how organizational structures, institutional norms, rules, and regulatory pressures influence individual behaviour within organizations. Chartier (2014) applied Organizational and Institutional Theory (OIT) to explain the role of institutional policies and management systems in biomedical waste management.

Figure 2.7 Organizational and Institutional Theory developed by Meyer and Rowan (1977) and DiMaggio and Powell (1983)

2.1.8 Environmental Ethics and Moral Responsibility Theory

Environmental Ethics and Moral Responsibility Theory emerged from the works of Aldo Leopold (1949) and was later expanded by Jonas (1984). The theory emphasizes moral obligations toward environmental protection, sustainability, and responsibility for the consequences of human actions. Schwartz (1977) used Environmental Ethics and Moral Responsibility Theory to explain the role of moral responsibility in environmentally responsible waste management practices.

2.1.9 Integrated TPB–NAM Framework

The Integrated TPB–NAM framework has been developed by incorporating into Ajzen's(p. 1) Theory of Planned Behavior and Schwartz and technology models people's own standards (1977). It is in line with recent research in the field that this new higher level axiomatic model needs information processing phenomenology to understand it. As maintained by some researchers of pro-environmental society pro-articles or other similar fields general ethical behavior during the first 10 years new century, this integrated model fuses a rational decision (or a calculation) with responsibility to society to explain behavior.

In this framework, personal norms influence attitudes and behavioural intention, while

attitude, subjective norms, and perceived behavioural control determine intention and actual behaviour. The integrated TPB–NAM framework is particularly suitable for studying biomedical waste management behaviour among healthcare professionals, as it captures ethical responsibility, social influence, and institutional control simultaneously.

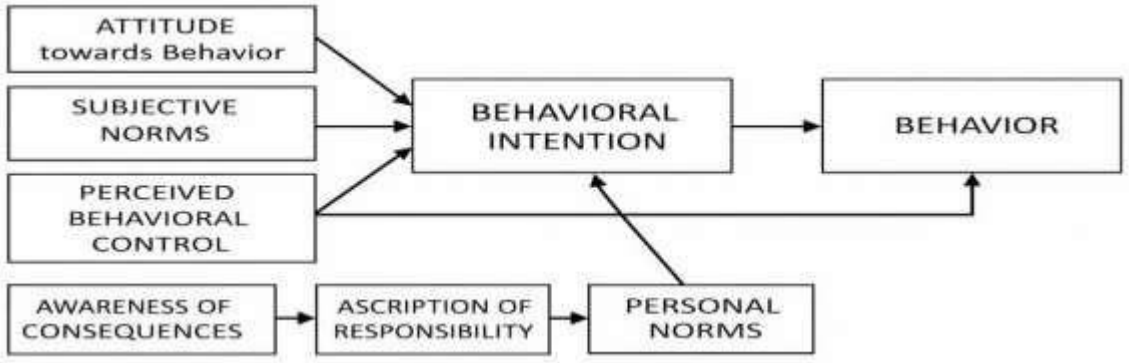

Figure 2.8 The Integrated TPB–NAM framework was developed by combining the Theory of Planned Behaviour (Ajzen, 1991) and the Norm Activation Model (Schwartz, 1977)

Table 2.1: Summary of Models in the areas of BMW

Model/Theory	**Origin**	**Key Constructs**	**Focus & Application in BMW**
KAP Model	Hochbaum (1958)	Knowledge, Attitude and Practice	**Education Focus:** Used to identify training gaps. (e.g., *Deress et al., 2018*)
Health Belief Model (HBM)	Rosenstock (1966)	Severity, Susceptibility, Benefits, Barriers	**Risk Focus:** Best for infection control/sharps safety. (e.g., *Shammi et al., 2020*)
Theory of Reasoned Action (TRA)	Fishbein & Ajzen (1975)	Attitude, Subjective Norms,	**Social Focus:** Highlights the role of peer pressure/norms. (e.g., *Sangkham, 2020*)

		Intention	
Theory of Planned Behavior (TPB)	Ajzen (1991)	Attitude, Subjective Norms, PBC	**Resource Focus:** Accounts for infrastructural barriers (bins/bags). (e.g., *Martin et al., 2021*)
Norm Activation Model (NAM)	Schwartz (1977)	Awareness of Consequences, Responsibility, Personal Norms	**Moral Focus:** Explains behavior driven by ecological conscience.
Social Cognitive Theory (SCT)	Bandura (1986)	Self-Efficacy, Observational Learning	**Learning Focus:** Emphasizes role-modeling and confidence.
Institutional Theory (OIT)	DiMaggio & Powell (1983)	Isomorphism (Coercive, Mimetic, Normative)	**System Focus:** Explains hospital-level adoption of technology. (e.g., *Jafarzadeh Ghoushchi, 2022*)
Integrated TPB-NAM	Al-Omran et al. (2025)	**Combination:** TPB (Rational) + NAM (Moral)	**Holistic Focus:** Merges practical capability with moral responsibility.

2.2.1 Phase-II of Literature Review

The phase II entails conducting a review of Systematic Literature Review (SLR) of articles published in indexed journals of Scopus. The literature review using a respected database like the Scopus is one of the most crucial steps in research. These websites provide large and

carefully edited collections of academic publications that ensure the reliability and relevance of the information obtained. Through these resources, researchers are able to identify existing gaps in knowledge or track the trend of research as well as justify the significance of their work in the broader academic community. This rigorous review process does not only strengthen the validity of research but also enables the development of knowledge that is well-informed and contextually based research proposals and papers thereby supporting the systematic and evidence-based development of knowledge. Systematic Boolean search was therefore done to find the published studies of relevancy on the Scopus database. The search query was as follows: ((“biomedical waste management” OR healthcare waste management OR medical waste management) AND (healthcare professionals OR doctors OR nurses OR paramedical staff or laboratory technicians or healthcare workers OR waste handlers)). Based on this search strategy, 327 articles were extracted on the Scopus database to be used in literature review (see Figure 2.9).

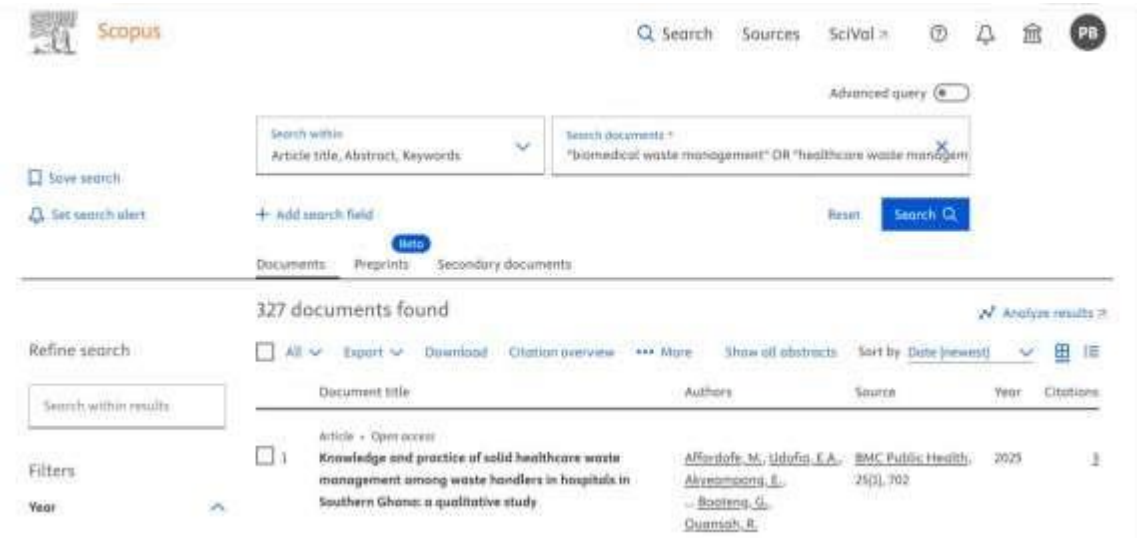

Figure 2.9: Boolean Exploration Results from Scopus Database

Table 2.2: Most utilized theories / models

Theory/Model	Theory/Model's Author	Utilisation (No. of Papers)
Theory of Planned Behaviour (TPB) and related models	Ajzen (1991)	229
Theory of Reasoned Action (TRA) and related models	Fishbein and Ajzen (1970)	109
Norm Activation Model (NAM)	Schwartz (1977)	70
Value- Belief- Norm (VBN) theory	Stern (2000)	61

Previous research shows that behavioural studies have extensively applied established theoretical models. The most popular one is the Theory of Planned Behaviour (TPB) introduced by Ajzen (1991), and a high number of empirical studies have been carried out concerning pro-environmental and waste management behaviours. Likewise, Theory of Reasoned Action (TRA), Norm Activation Model (NAM), and Value belief Norm (VBN) theory has also been implemented in different contexts in the environment and related to health care. Nevertheless, even though there is adequate amount of research done with these models separately; there are very small researches that have combined TPB and NAM, especially in the chosen section in the Kumaun region in Uttarakhand. The majority of the existing research has been carried out in large cities or developed areas, and there is a gap in the context of comprehending the behavioural and moral determinants in healthcare professionals in this area.

Therefore, to address this theoretical and geographical research gap, the present study integrates the Theory of Planned Behaviour (TPB) and the Norm Activation Model (NAM) to provide a more comprehensive understanding of biomedical waste segregation behaviour. This integrated approach enables the study to capture both rational decision-making factors (attitude, subjective norms, perceived behavioural control) and moral–normative influences (awareness of consequences, ascription of responsibility, and personal norms), which have rarely been examined together in the selected region.

Table 2.3 Bibliometric Analysis of the Extracted Literature from the Scopus Database (n = 327)

Year	No. of Articles
2002	1
2004	2
2005	3
2006	4
2007	5
2008	7
2009	6
2010	9
2011	8
2012	10
2013	14
2014	17
2015	22

Stakeholders	No. of Articles
Healthcare professionals	142
Doctors	61
Nurses	74
Paramedical staff	22
Waste handlers	18
Others	10
Grand Total	**327**

Language	No. of Articles
English	314
Spanish	6
Chinese	3
Portuguese	2

2016	15
2017	28
2018	26
2019	31
2020	35
2021	52
2022	58
2023	42
Grand Total	**327**

French	2
Grand Total	**327**

Type of Article	**No. of Articles**
Article	229
Review	41
Conference paper	44
Book chapter	13
Grand Total	**327**

Systematic Literature Review (SLR) of the various articles and also thesis extracted from the Shodhganga portal is presented using PRISMA flow chart were prepared and shown in Figure 2.10.

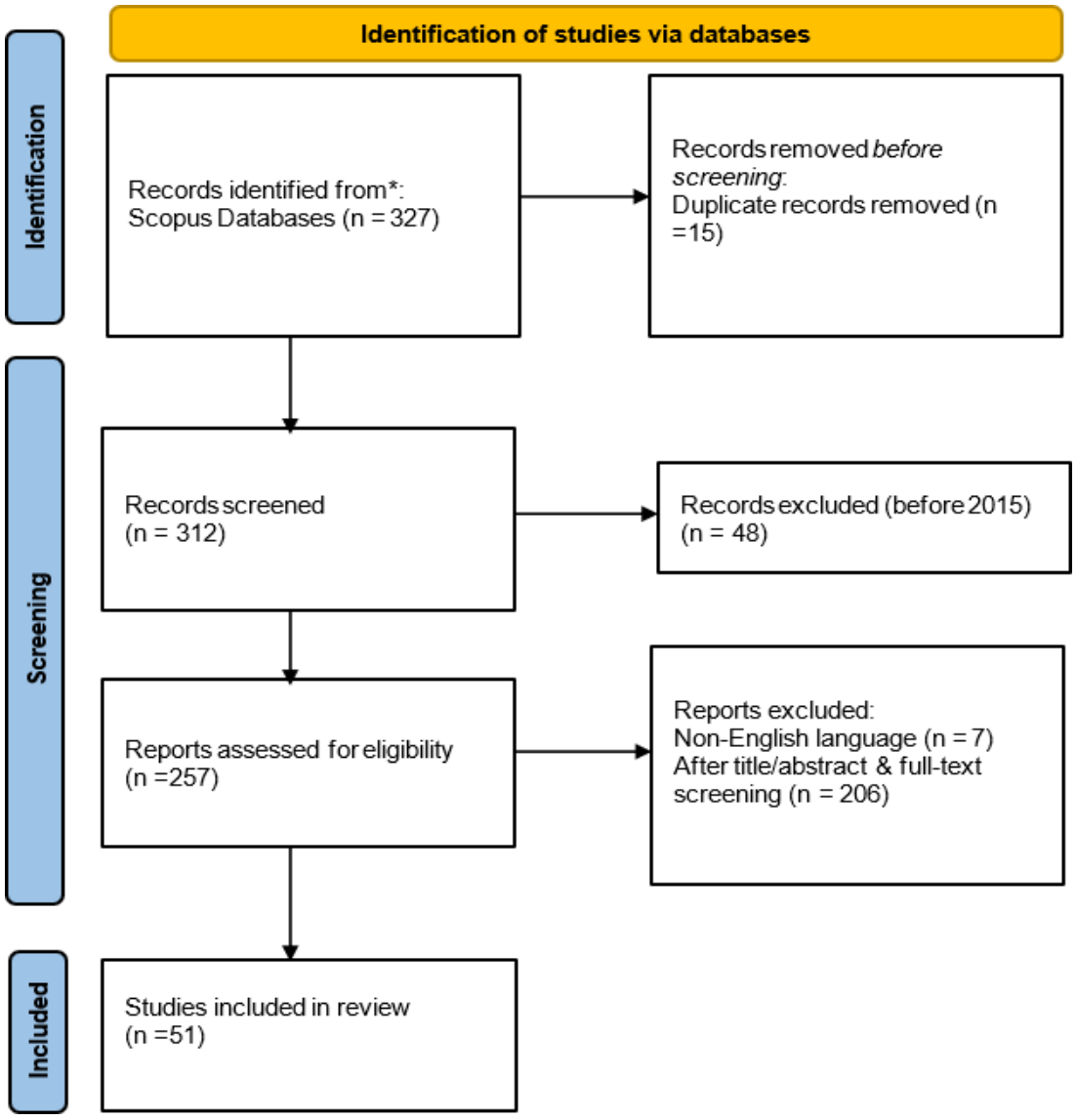

Figure 2.10: Flow diagram for the selection of study

3. Research Gap

Despite the presence of clear regulatory guidelines such as the Biomedical Waste Management Rules (2016 and subsequent amendments), improper biomedical waste segregation remains a major concern in healthcare settings, especially in developing and resource-limited regions (MoEFCC, 2016; WHO, 2017). Though some researchers have conducted research on the biomedical waste management practices among healthcare professionals, they fail to fill the major research gaps (Mathur et al., 2011; Deress et al., 2019). Theoretically, the majority of the past research involved individual models including the Norm Activation Model (NAM) or the Theory of Planned Behaviour (TPB) (Ajzen, 1991; Schwartz, 1977). Although TPB can explain the intention to behave based on the attitude, subjective norms and perceived behavioural control, it is inadequate in the context of moral

and ethical obligation to protect the environment (Bamberg and Moser 2007). Conversely, research grounded on Norm Activation Model (NAM) concentrates more on the moral obligations without paying much attention to practical and institutional limitations (Steg and Vlek, 2009). At the moment, literature that combines the Theory of Planned Behavior (TPB) and the Norm Activation Model (NAM) to analyze biomedical waste sorting behaviors is in short supply. This omission accounts for the absence of studies looking at how people are both compelled by reason and moved with compassion to act according to such behavior norms (Klockner,2013). In terms of methodology, previous work has been based largely on quantitative, cross-sectional research designs and has heavily relied upon self-reported surveys (Mathur et al., 2011; Ali et al., 2017). These studies fail to provide elaborate insight into what real problems confront health professionals--the very people responsible for bringing meaningful waste separation actions to the front lines (Deress et al., 2019). In terms of research context and geographical span, past studies have mostly taken place in urban areas where fully equipped tertiary healthcare facilities are available (Patil, 2005; Ali et al., 2017). Empirical research has rarely been done in places with difficult geographical environments such as the Kumaun region of Uttarakhand, India--a place that lacks formal waste disposal facilities, roads are often impassable due to rain and mudslides or snowfall; it has weak infrastructure, people may lack workable water supplies near their homes and there return may be difficult when they fall sick. these restrictions make healthcare provision more challenging than ever.

This current state of affairs not only raises questions regarding the generalizability of existing research findings but also underscores the critical need for conducting context-specific field studies.

Table 3.1: Identified Research Gaps and Opportunities in Biomedical Waste Segregation/Management

Gap Category	Description
Theoretical Gap	Most previous studies have used single behavioural models such as TPB or NAM. Very limited studies have integrated both models, leading to an incomplete understanding of the combined influence of rational decision-making and moral responsibility on biomedical waste segregation behaviour.

Methodological Gap	Existing research is predominantly quantitative and cross-sectional in nature. Therefore, a mixed-method approach combining both quantitative and qualitative methods is required to gain deeper insight into the gap between knowledge, intention, and actual practice.
Contextual & Geographical Gap	Prior studies are mainly concentrated in urban and tertiary healthcare institutions. There is very limited empirical evidence from resource-constrained and geographically challenging regions such as the Kumaun division of Uttarakhand.

3.1. Research Questions

RQ1. How do the Theory of Planned Behaviour constructs—attitude, subjective norm, and perceived behavioural control influence biomedical waste management intention among healthcare professionals?

RQ2. How do Norm Activation Model variables—awareness of consequences, ascription of responsibility, and personal norms—influence biomedical waste management intention and biomedical medical waste segregation behaviour among

healthcare professionals?

RQ3. What role does personal norm play in mediating the relationship between NAM variables and biomedical waste segregation intention and behaviour?

RQ4. To what extent does biomedical medical waste segregation intention translate into actual biomedical medical waste segregation behaviour?

RQ5. To what extent does an integrated NAM–TPB model explain biomedical waste management intention and behavior among healthcare professionals in the Kumaun region of Uttarakhand?

4. Research Objectives

In alignment with the integrated TPB–NAM model, the study aims to achieve the following objectives:

1. To examine the influence of attitude, subjective norm, and perceived behavioural control

on biomedical waste segregation intention among healthcare professionals in the Kumaun region of Uttarakhand.

2. To assess the impact of awareness of consequences and ascription of responsibility on the development of personal norms related to biomedical waste segregation.
3. To analyze the role of personal norm in shaping biomedical waste segregation intention and behaviour.
4. To investigate the relationship between medical waste segregation intention and actual medical waste segregation behaviour.
5. To empirically test and validate an integrated TPB–NAM model for explaining biomedical waste segregation behaviour in healthcare settings.

5. Conceptual Framework & Hypothesis Development

Based on a review of behavioural and moral norm–based theories, the present study adopts an integrated framework combining the Theory of Planned Behaviour (TPB) and the Norm Activation Model (NAM) to examine biomedical waste management among healthcare professionals. The framework focuses on TPB variables—attitude, subjective norm, and perceived behavioural control—and NAM variables—awareness of consequences, ascription of responsibility, and personal norms—to understand biomedical waste management intention and practice. Further, the moderating role of type of healthcare institution and location is examined to explain variations in biomedical waste management behaviour.

Constructs:

- Dependent variables are Biomedical Waste Management Behavior (BWMB)
- Independent variables - From Theory of Planned Behaviour (TPB), Attitude, Subjective Norm, Perceived Behavioral Control. Intentions of participation in period the day before with stage variables into direct conclusion. Such as From the Norm Activation Model: Awareness of Consequences and Ascription Responsibility (AR)

Definitions of Constructs

- Attitude (ATT): The degree to which a health worker has for herself or himself 1 positive or negative view on work related biomedical haste sorting at work (Ajzen, 1991).

- Subjective Norm (SN): The health care worker s perception of what his or her friends, superiors and hospital expect from him or her in fulfilling proper health in-formation its sorting at work (Ajzen, 1991).
- Perceived Behavioural Control (PBC): Health professionals' sense the biomedical waste segregation is easy or how hard situation resource availability, information on it given, time interval and institutional support (Ajzen, 1991).
- Biomedical Waste Segregation intention (BWSI): How well a health care worncr is prepared better able to perform right and western style separation of biomedical waste, in accordance with the given guidance requirements (Ajzen, 1991).
- Behavior Toward Biomedical Waste Segregation (BWSB): Behavior sufficient methods of waste separation are 1X1 health care workers who biomedical remove bio-medical mercy Hospital, of course consistent with the slot price business as usual operation (Ajzcn, 1991).
- Awareness of Consequences (AC): The degree to which a healthcare professional is aware of the potential negative consequences of improper biomedical waste segregation on human health, public safety, and the environment (Schwartz, 1977)
- Ascription of Responsibility (AR): The notch to which a healthcare professional feels personally responsible for the consequences arising from improper biomedical waste segregation (Schwartz, 1977)
- Personal Norm (PN): The internalized moral obligation felt by a healthcare professional to perform proper biomedical waste segregation, irrespective of external pressures or enforcement mechanisms. (Schwartz, 1977)

Dependent variables is Biomedical Waste Management Behavior (BWMB)

Independent Variables are From TPB: Attitude, Subjective Norm, and Perceived Behavioural Control

From NAM: Awareness of Consequences, Ascription of Responsibility.

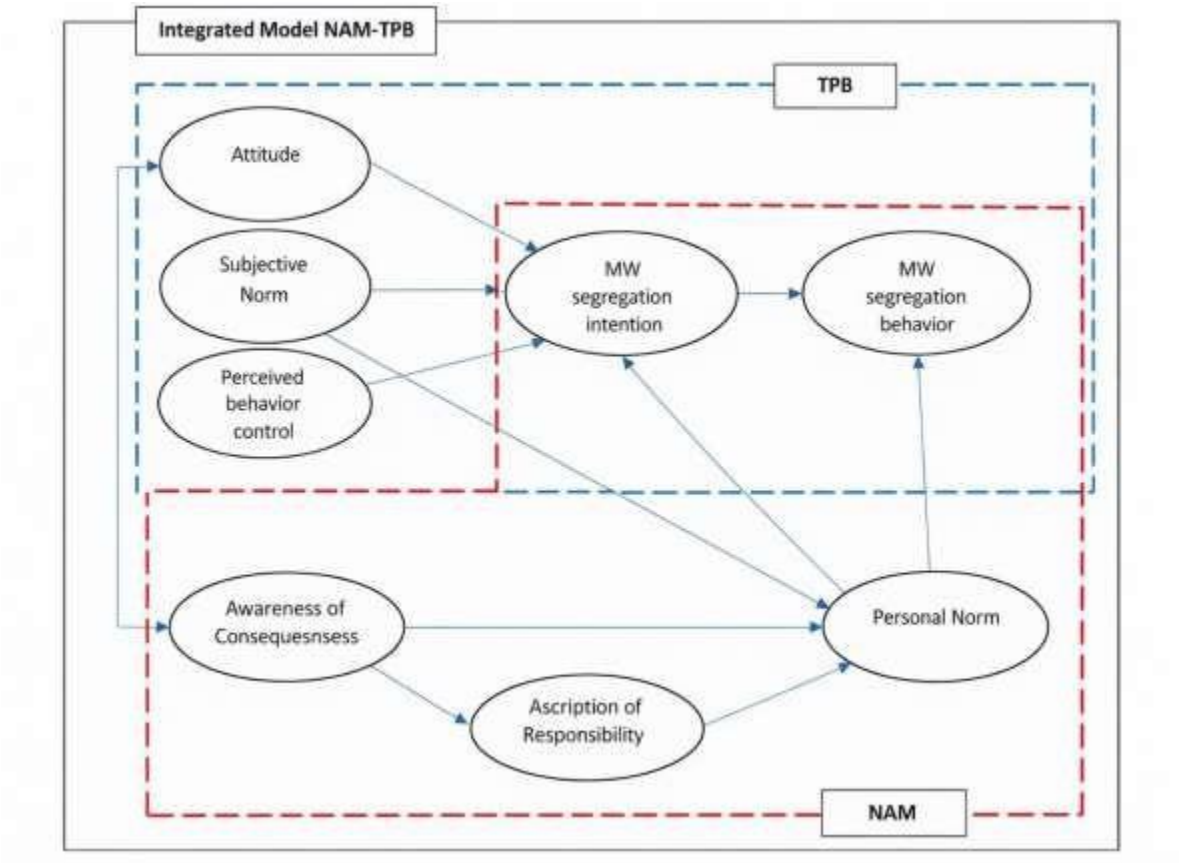

Figure 5.1: Theoretical framework of Proposed Model

5.1 Proposed Hypothesis

TPB-related Hypotheses (Attitude, Norms, Control → Intention)

H1: Attitude towards biomedical waste segregation has a significant positive influence on biomedical waste segregation intention among healthcare professionals in the Kumaun region of Uttarakhand.

H2: Subjective norm has a significant positive influence on biomedical waste segregation intention among healthcare professionals in the Kumaun region of Uttarakhand.

H3: Perceived behavioural control has a significant positive influence on biomedical waste segregation intention among healthcare professionals in the Kumaun region of Uttarakhand.

NAM-related Hypotheses (Awareness → Responsibility → Personal Norm)

H4: Awareness of consequences of improper biomedical waste management has a significant positive influence on ascription of responsibility among healthcare professionals.

H5: Awareness of consequences has a significant positive influence on personal norms related to biomedical waste segregation.

H6: Ascription of responsibility has a significant positive influence on personal norms related

to biomedical waste segregation.

Integration of NAM and TPB (Personal Norm → Intention & Behaviour)

H7: Personal norm has a significant positive influence on biomedical waste segregation intention among healthcare professionals.

H8: Personal norm has a significant positive influence on biomedical waste segregation behaviour among healthcare professionals.

Intention–Behaviour Relationship

H9: Biomedical waste segregation intention has a significant positive influence on actual biomedical waste segregation behaviour among healthcare professionals.

H10: The integrated TPB–NAM model provides a significant explanatory framework for biomedical waste segregation behaviour among healthcare professionals in healthcare settings.

6. Research Methodology

6.1 Research Design: Explanatory Sequential Mixed Methods Design

This study will employ a mixed-method design to analyze the data. This design involves the initial collection and analysis of quantitative data, followed by the collection and analysis of qualitative data. The qualitative phase is specifically utilized to explain and interpret the quantitative findings in greater depth, delving into the underlying reasons for observed patterns.

- **Phase 1 (Quantitative):** A cross-sectional survey will be conducted to validate the various predictors of medical waste segregation behaviour among healthcare professionals using the theories of NAM and TPB.
- **Phase 2 (Qualitative):** Following the analysis of the quantitative data, in-depth semi-designed interviews will be conducted with a purposefully selected subset of participants. The selection of these participants will be guided by the quantitative findings (e.g., individuals exhibiting high knowledge but low practice, or those working in facilities with specific challenges). The qualitative data collection will aim to explore the "why" and "how" behind the observed quantitative patterns, identify specific barriers and facilitators (such as infrastructural, organizational, or social factors), and gather nuanced perspectives on BMWM challenges unique to the Kumaun region.

The value of this mixed-methods design for the current study is multifaceted. It allows for both breadth and depth, enabling the quantification of NAM and TPB constructs across a larger population while simultaneously delving into the contextual factors and underlying reasons for these patterns. The method is especially successful in that it provides a deeper understanding of "knowledge-practice gap" as well as other internal contradictions that may arise within quantitative data. Moreover, by reporting on the infrastructure and local practices of Kumaun Apart from helping readers understand various problems through data, it assists yekipin zhong knowledge (ie, healthcare professionals) in this area susceptible to unique challenges in total detail. Quotingexperience'A new Era of Hope This design is arguably crucial: it enables us to obtain a multi-faceted understanding that not only targets individual behavior but also includes system problems within BMWM framework.

6.2 Study Area and Population

- **Study Area:** The research will be conducted in the Kumaun region of Uttarakhand, India. This region is geographically characterized by its hilly terrain and has documented challenges in waste management infrastructure. Specific districts within Kumaon, such as Nainital, Almora, and Udham Singh Nagar, will be selected to ensure representation of diverse healthcare settings, including urban, semi-urban, and rural areas.
- **Study Population:** The study population will comprise healthcare professionals (HCPs) who are directly involved in patient care and the generation or handling of biomedical waste within the selected healthcare facilities. This will include, but not be limited to, doctors, nurses, laboratory technicians, and sanitary staff.
- **Healthcare Facilities:** A purposive sample of both public and private healthcare facilities will be selected to capture a diverse range of practices and challenges. This will include Tertiary care hospitals/Medical Colleges, district hospitals, community health centers (CHCs), primary health centers (PHCs), and potentially large private hospitals or nursing homes. The selection process will consider the reported number of HCFs in Uttarakhand (4,442 HCFs in 2020) and the working capacity and accessibility of local common biomedical waste treatment and disposal facilities (CBWTFs).

6.3 Sampling Strategy

Phase 1 (Quantitative):

- Sampling Frame: A comprehensive list of all registered healthcare facilities (both public and private) in the selected districts of Kumaun will be obtained from the Uttarakhand Pollution Control Board (UKPCB) or other relevant health authorities viz office of clinical establishments.

- Facility Selection: The use of stratified random sampling to select a representative sample of healthcare facilities, stratified by facility type (such as tertiary care hospital, district hospital, CHC / PHC, private hospital) and bed capacity, will ensure that different contexts in healthcare are equally represented.

- Participant Selection: in each selected facility, healthcare practitioners of different ranks (doctors, nurses, laboratory technicians and hygiene workers will be chosen according to a proportionate or convenience stratified random sample. This will depend on how feasible it is and what degree of cooperation we can expect from facilities.

- **Sample Size Calculation:** The sample size for the quantitative phase will be calculated using appropriate statistical formulas. This calculation will consider the estimated population of healthcare professionals in Kumaun, the expected prevalence of satisfactory scores, the desired level of precision, the confidence level, and a design effect to account for cluster sampling.

6.4 Data Collection Instruments

- **Phase 1 (Quantitative): Structured Questionnaire**

A pre-tested, semi-structured, and self-administered questionnaire will be developed for this phase. The questionnaire will draw upon validated instruments used in previous TPB and NAM studies within healthcare settings.

- **Phase 2 (Qualitative): Semi-structured Interview Guide**

An interview guide will be systematically developed to explore themes emerging from the quantitative findings and to delve deeper into specific barriers and facilitators of BMWS.

6.5 Ethical Considerations

The study will strictly adhere to the National Ethical Guidelines for Biomedical and Health Research Involving Human Participants, 2017, issued by the Indian Council of Medical Research (ICMR).

- **Informed Consent:** Detailed informed consent will be obtained from all participants. This process will ensure they fully understand the study's purpose, the procedures involved, their absolute right to withdraw at any time without penalty, and the stringent measures taken to protect their confidentiality.
- **Confidentiality and Anonymity:** All data collected will be maintained in the strictest confidence. During data entry, analysis, and report the participant will be assigned any identifying information anonymised names Audio recordings, after transcription verification are destroyed promptly. They are stored in a secure manner.
- **Voluntary Participation:** Taking part in the study is entirely voluntary. There will be no attempts to coerce or otherwise unduly influence prospective participants.
- **Minimizing Harm:** The research design is carefully structured so as to ensure that participants suffer no physical, psychological, or social harm. Questionnaire items and interview questions will be drafted with sensitivity to avoid distress.
- **Beneficence:** The study is designed with the aim of contributing to tangible improvements in BMWM practices. By doing so, it seeks to ultimately benefit public health and environmental well-being within the Kumaun region.
- **Justice:** Efforts will be made to include a diverse range of healthcare professionals and facilities in the sample. This approach ensures that the findings are representative across different groups and that the potential benefits of the research are distributed equitably.

6.6 Statistical Tools for Analysis

Descriptive statistics will be used to explain the basic characteristics of the data collected. Parametric/Non-Parametric Tests and Structural equation Modeling will be used to analyze structural relationships between measured variables and latent constructs. MS-Excel, R-Studio, Smart PLS etc. will be used to analyze the data.

Table No.6.1 Proposed Mixed-Methods Design: Data Sources, Collection Methods, and Integration Points

Phase	1 (Quantitative)	2 (Qualitative)
Research Question Addressed	What are the levels of knowledge, attitudes, and practices of BMWM among HCPs? What are the influences of attitude towards behavior, subjective norms, and perceived behavioral control on practices?	Why do HCPs exhibit specific BMWM practices? What are the underlying barriers and facilitators (infrastructural, systemic, behavioral)? How do HCPs perceive the challenges in Kumaun?
Data Type	Numerical	Textual
Data Source	HCPs in selected HCFs	Subset of HCPs from Phase 1
Phase	**1 (Quantitative)**	**2 (Qualitative)**
Collection Method	Structured Questionnaire (NAM & TPB scales)	Semi-structured Interviews
Analysis Method	Descriptive & Inferential Statistics (e.g., Regression)	Thematic Analysis
Integration Point & Purpose	Informing Qualitative Phase: Quantitative results (e.g., low practice scores despite high knowledge, specific TPB constructs as strong predictors) will guide the selection of qualitative participants and the focus of interview questions to explore "why" these patterns exist.	Explanation & Elaboration: Qualitative themes and narratives will explain the quantitative findings (e.g., explaining low PBC due to lack of bins/CBWTFs, or the knowledge-practice gap due to poor management support). Joint Displays: Visual representation of integrated

		findings in tables/matrices to show how qualitative insights deepen quantitative understanding.

7. Scope of the study

The present study focuses on examining biomedical waste management practices among healthcare professionals in the Kumaun region of Uttarakhand. It investigates the role of behavioural and moral determinants influencing biomedical waste segregation by integrating the Theory of Planned Behaviour (attitude, subjective norm, and perceived behavioural control) and the Norm Activation Model (awareness of consequences, ascription of responsibility, and personal norms).The scope of the study is limited to healthcare professionals working in selected healthcare institutions, including both public and private hospitals. The study looks at which staff intend to separate biomedical waste and which they do in practice in the health care setting. Also, we look at how type of health care institution and location play a role in that which variables do and do not play out as expected which in turn presents a picture of why we see the differences in management of biomedical waste. We have made use of mixed research, a method that incorporates both quantitative data on survey and qualitative data to get a comprehensive picture of bio medical waste management behavior. We propose that the research will complement policy formulation, training, and institutional strategies that in turn could bring about better management of biomedical waste in the health care facility.

8. Practical Implications and Limitation of the Study

We believe that this study will provide practical and actionable information to the policy makers and hospital administrators who are interested in enhancing the management of biomedical waste in health care facilities. Since the personal norms and the perceived behavioural control turns out to be important predictors of behaviour, the interventions are to be shifted beyond extensive awareness campaigns and concentrate on two areas. First, the moral responsibility should be reinforced with training and sensitization programmes that can make the improper

disposal of biomedical waste closely linked to environmental and health impacts, thus making healthcare professionals have a sense of personal responsibility. This kind of approach will be most effective compared to the initiatives meant to change attitudes alone which were discovered to have no serious effect. Second, to amplify the perceived behavioural control, the hospital management must make sure it has easy and readily accessible, and in good condition waste segregation points, so that healthcare professionals can effectively and confidently perform waste segregation. Moreover, the minor importance of the social norm implies that interventions are expected to consider internal motivation and individual responsibility as the primary options, instead of putting the focus on peer influence first.

This study is subject to certain limitations that should be considered while interpreting the findings. Firstly, the geographical scope of the study is restricted to the Kumaun region. While this allows for focused contextual analysis, it may limit the generalizability of the findings to other regions with different socio-cultural, institutional, or healthcare infrastructure settings. Secondly, the study population is confined to healthcare professionals. Although this group is directly relevant to the research objectives, the exclusion of other stakeholders (such as patients, administrative staff, or policymakers) may result in a narrower perspective on the issue under investigation. Thirdly, the study adopts a cross-sectional research design, which captures data at a single point in time. As a result, it does not allow for the valuation of temporal changes or causal relationships between variables. Additionally, the belief on self-reported data familiarizes the possibility of response biases, including social desirability bias and recall bias, which may affect the accurateness of the responses. Finally, the study is grounded in an integrated Theory of Planned Behavior (TPB) and Norm Activation Model (NAM) framework. While this combined theoretical approach provides a comprehensive lens for understanding behavioral intentions, it may not fully capture all contextual or external factors influencing behavior. Thus, there are inherent theoretical limitations associated with the chosen framework. Despite these limitations, the study provides valuable insights within its defined scope and contributes meaningfully to the existing body of knowledge.

Annexure-1

Proposed Semester-wise plan of work and targets to be achieved:

S. No.	Activities	Period
1	Course Work	Mar-Aug, 25
2	Preparation and Defence of the Thesis Proposal (Synopsis)	Aug, 25 – Feb, 26
3	Questionnaire Development & Validation, Sampling Design, Pilot Testing and Refinement of Questionnaire	Mar-Aug, 26
4	Data Collection, Data Preparation: Coding and Cleaning	Aug, 26 – Feb, 27
5	Data Analysis and Results	Mar-Aug, 27
6	Thesis Writing, and Pre-PhD Seminar	Aug, 27 – Feb, 28

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